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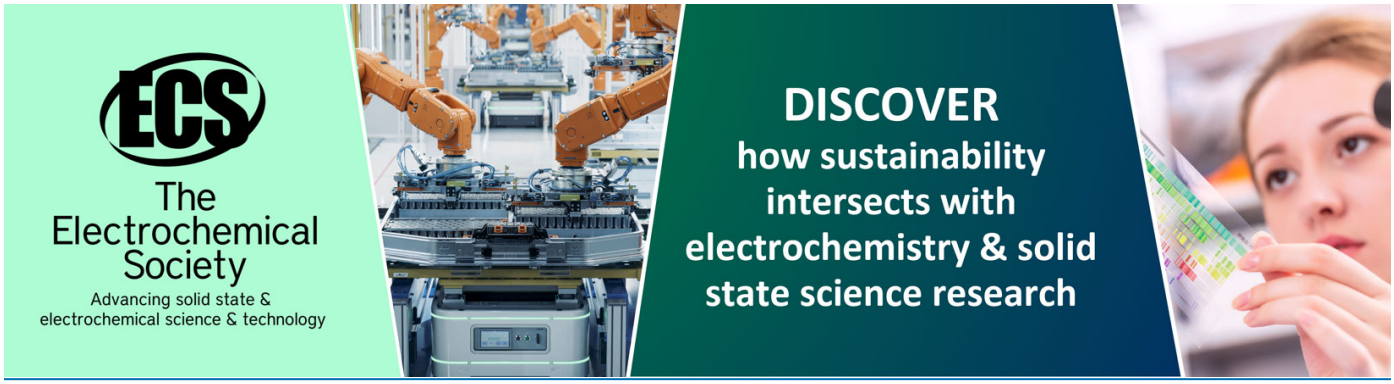

Coulomb explosion of polycyclic aromatic hydrocarbons induced by heavy cosmic rays: carbon chains production rates

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Synopsis The interstellar medium contains both polycyclic aromatic hydrocarbons and cosmic rays. The frontal impact of a single heavy cosmic ray strips out many electrons. The highly charged species then relax by multi-fragmentation, potentially feeding the interstellar medium with hydrocarbon chains. We model both ionization(s) and fragmentation processes and compute the fragments production rates of particular interest for astrophysical models.

Low energy CRs consist of projectiles from proton to nickel with energy from 10 keV to GeV. Astrophysical PAHs are carbons structures with cycles containing from ten's to few hundred's of carbon atoms. We report on the coulomb explosion of highly positively charged PAHs induced by the interstellar low energy CRs leading to the formation of long carbon chains.

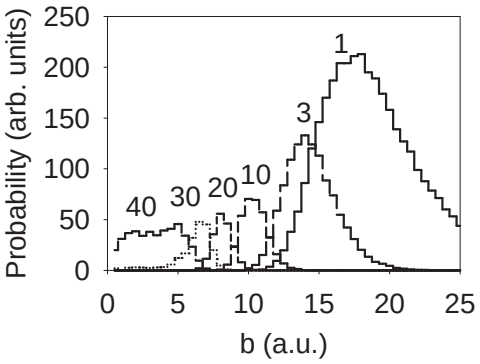

Figure 1. Relative ionization probabilities as function of the impact parameter for C_{60} and iron projectile at 1.1 MeV/u. The label on the curves corresponds to the ionization fold.

To calculate the ionization cross sections, we employ the so-called independent atom and electron (IAE) model [1] where all atoms and electrons are treated as independent. The IAE probabilities thus consist of the products of atomic probabilities. The impact parameter probabilities of Q fold ionization's for an iron projectile at 5MeV/u on a C_{60} is shown in Fig.1 as an example of such calculation.

To calculate the charge state above which the PAH multi-fragments, we used a statistical model in a microcanonical formalism based on the experimental work of S. Martin [3]. The internal energy was compute with the IAE model. To retrieve the figure of fragmentation in the multi fragmentation process of the multi-charged species, we extend a statistical model construct initially for small multi-charged carbon C_n(n=2 to 10)[2].

The size of the carbon chains resulting from the coulomb explosion extends up to 10 to 15($\pm$3) carbon atoms, depending on the size, compactness and hydrogenation degree of the PAHs. Their production rates are weakly depending on their sizes. The carbon chains production rates range from a few to many tens of percents of the H_2 ionization rate, depending on the PAH structure and the adopted CR type (i.e. Galactic standard spectrum or closer to a local CR source with a steeper low energy flux distribution) [4].

References

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